

INSECT PESTS OF SOUTHERN PINES

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William H. Bennett and H. Eugene Ostmark

This booklet describes the identification, habits, and control of the common insect pests of southern pine trees. It is applicable throughout the South and to all 10 southern pine species, though naturally loblolly, longleaf, shortleaf, and slash pines are of chief concern.

The booklet supersedes Occasional Paper 164, "Insect enemies of southern pines," published in 1958 by the Southern Forest Experiment Station. The text includes knowledge developed by research and experience since 1958, and Ostmark has prepared entirely new drawings to depict types of damage, symptoms of attack, and important characteristics of insect life stages. The aim throughout has been to provide foresters, landowners, county agents, and students with up-to-date facts in a form that can be easily understood. Statements about the protection of ornamental pines have been included where appropriate.

A strong effort has been made to describe silvicultural and other alternative controls in lieu of pesticides that may harm fish and wildlife if improperly applied. It is recognized, however, that severe outbreaks may develop through unavoidable circumstances, regardless of precautions taken. When such outbreaks threaten high-quality crop trees, seed trees, or other valuable pines, the only recourse may be to apply a suitable chemical. Chemicals are most likely to be needed with infestations of the black turpentine beetle and the redheaded pine sawfly. For information on current pesticide recommendations and the best approach to direct control, the land manager should contact his State forestry agency or the Pest Management Group of State and Private Forestry, USDA Forest Service, Atlanta, Georgia.

PINE INSECTS OF THE SOUTH

	INSECT	SIGNS OF ATTACK	Page
BARK BEETLES	Southern Pine Beetle Bores under bark and girdles trees of various sizes. Attacks middle and upper stem in fall and winter and lower stem in spring and summer. In outbreaks it may kill millions of dollars of green timber.	Small, usually white pitch tubes on bark. Sometimes only boring dust. S-shaped and crisscrossed tunnels engraved in inner bark. Beetles brown to black, about 1/8-inch long. Rounded hind end, minute notch on front of head when viewed from above.	4
	Ips Engraver Beetles Bore under bark and girdle trees of small and commercial size. Not as spectacular as the southern pine beetle but always present and do considerable damage.	Small, usually reddish pitch tubes on bark of trunk. Sometimes just red boring dust in cracks of bark and on ground. Y- or H-shaped tunnels, almost straight and parallel with wood grain, on inside bark. Beetles reddish to dark brown or black, 1/4-inch long or less; hind end cut-off and shovel-shaped.	7
	Black Turpentine Beetle Girdles inner bark of stumps and butts of large trees. After logging, fires, and other disturbances, may increase and kill trees, especially trees that have been scarred, turpentine-faced, or otherwise damaged.	Large, sugar-like pitch tubes on stumps and lower trunk. Hard particles of resin at tree base. Tunnels on inner bark are more or less shapeless, and contain considerable pitch. Larvae feed in groups and eat out whole patches of inner bark. Beetles typically black, about 1/4- to 1/3-inch long.	11
WOOD BORERS	Southern Pine Sawyers Round-headed borers tunnel in dead and dying trees and fresh-cut logs. The tunnels cause severe defects in lumber.	Pencil-size and larger holes in sapwood and heartwood, with coarse excelsior-like frass. Funnel-shaped holes in bark where eggs have been deposited. Grayish beetles, 1 inch in length, with very long antennae.	14
	Turpentine Borer Flat-headed borer in fire-scarred and turpented trees. Degrades lumber and weakens stems so that they may break from wind or ice.	Elliptical emergence holes on fire scars and particularly in turpentine faces. Larval tunnels filled with tightly packed fine frass and resin. Trees broken off about breast height during high winds. Beetle 1 inch long with metallic luster.	16
	Ambrosia Beetles Pin-hole borers in dying trees, logs, and unseasoned lumber. Make small holes in the wood and introduce a dark stain.	Pin-hole damage and black stain in lumber. Piles of fluffy white boring dust on ground and in bark crevices. Shiny red, cylindrical beetles about 1/4-inch long.	18
ROOT, TWIG, AND EXTERNAL BARK FEEDERS	Nantucket Pine Tip Moth Bud and shoot destroyer of seedlings and saplings. Causes the trees to become bushy and stunted. Seedling growth may be severely retarded.	Undeveloped buds and dead shoots hollowed out. White crust of resin near bud. Small, yellowish to brown larvae or pupae inside bud or shoot. Moth about 3/4-inch long, reddish-brown with silver-gray markings. Flies around foliage at dusk during summer.	20
	Pine Weevils External and inner bark feeders and girdlers of seedlings and sometimes leaders of young saplings.	Planted or natural seedlings with bark girdled externally above or below groundline, or with larval tunnels and borings in inner bark. Weevils are red-brown to black, 1/4- to 1/2-inch long, heavy-bodied, and with a prominent snout.	22
	White Grubs Root feeders on nursery seedlings and young plantation stock.	Foliage of seedlings fading and dying. Roots girdled or chewed off. White grubs in soil near roots. Adults (May beetle) attracted to lights, feed on hardwood foliage.	25
LEAF FEEDERS	Red-headed Pine Sawfly Needle chewer. Trees are weakened and occasionally killed by repeated defoliation. Growth loss may be severe.	Needles chewed to short stubs, manure pellets on ground. Masses of worm-like larvae feed together. Red-brown heads, yellow bodies with black spots, about an inch in length, many small legs.	28
	Loblolly Pine Sawfly Needle chewer. Prefers loblolly pine. Defoliates pines from March to May, occasionally causing heavy growth losses.	Needles chewed and trees defoliated, manure pellets on ground. Groups of worm-like larvae up to about an inch in length. Red-brown heads, bodies dull green and gray striped, many small legs on body. Difficult to see on foliage.	28
	Sawfly <i>Neodiprion excitans</i> Needle chewer.	Larvae same as above except with black heads and black spots along sides of green and gray striped body.	28
	Pine Webworm Defoliates seedlings in nurseries and young plantations.	Seedlings have masses of silk webbing mixed with excrement pellets. Caterpillar in each web is about 3/4-inch long. Caterpillars have tan heads and yellowish bodies with two dark-brown stripes along each side.	32
	Pine Colaspis Beetle Feeds on needles of natural and planted seedlings and larger trees.	Needles appear as if singed by fire and are highly reflective at night. Most noticeable in June and July. Small, tan beetles, with brown stripes.	34
MISCELLANEOUS INSECTS	Texas Leaf-Cutting Ant Defoliates seedlings during winter. Serious problem in parts of Louisiana and Texas.	Needles, bark, and buds removed from natural and planted seedlings. Large red-brown ants live in towns made up of many conspicuous mounds.	36
	Pine Needle Miner Burrows and feeds within needles. Probably causes growth loss.	Conspicuous browning and yellowing of needles. Partly hollowed needles with excrement particles and minute holes. Yellow-brown larva or pupa in each needle.	39
	Pine Pitch Midge Attacks twigs and lives in glob of resin. Common but of little economic importance.	Small masses of semifluid resin containing yellowish-orange larvae with occasional swelling of plant tissue. Twigs sometimes swell under the pitch glob and later break off.	39
	Scale Insects Suck sap from needles and twigs. Occasionally become very numerous, reducing tree vigor and killing young pines.	Scale-like insects covering needles or twigs. Fading or browning foliage in severe infestation, with honeydew present. Black, sooty fungus grows on honeydew.	39
	Aphids Suck sap from needles, bark, roots. Cause growth loss and malformation.	Soft-bodied plant lice on foliage or bark. Honeydew present, often with sooty fungus.	40
	Spider Mites Suck sap from needles and twigs. Sometimes kill ornamental conifers.	Spotty, pale-green and brown foliage. Fine webbing with cast skins and eggs or mites on needles or twigs. Mites can be seen by shaking foliage on white paper.	40

SOUTHERN PINE BEETLE

Dendroctonus frontalis

The southern pine beetle is the most dangerous and the most dreaded insect enemy of southern pines. It attacks trees of pulpwood and sawtimber size, which it quickly kills by girdling and also by introducing a bluestain fungus that plugs conductive tissues. The stain degrades lumber. The insect is especially destructive in stands of poor vigor, where outbreaks are often triggered by soil-moisture stresses and by man-caused disturbances.

Habits.—The small, $\frac{1}{8}$ -inch long, cylindrical beetle is brown to almost black. Its hind end is rounded, in contrast to the chopped-off or shovel-shaped posterior of *Ips* beetles (fig. 1). When the beetle is viewed from above with a hand lens, a notch formed by two minute tubercles may be seen on the front of the head (fig. 2).

The insect first attacks weakened and damaged trees, either singly or in small groups, and may later spread over large acreages. In pairs of male and female, the beetles invade the tree's main stem; during outbreaks thousands of adults may attack a single tree. Each pair constructs an S-shaped tunnel, about 1 foot long, between the bark and wood. The tunnels crisscross and form an intricate pattern that girdles the tree. Eggs are deposited in niches along the tunnels. The whitish larvae usually feed in the inner and outer bark, and may be exposed by whittling away the bark surface with a hatchet. After a few weeks the larvae change to pupae and then transform to adults. In warm months, the life cycle is completed in about 30 days. There may be four to seven generations yearly, the greatest number occurring in the lower Gulf Coastal Plain. Generations overlap considerably at all seasons.

Population buildups are often violent and hard to predict. When an epidemic has run its course, the insects may disappear as rapidly as they came; in some years it is nearly impossible to find any

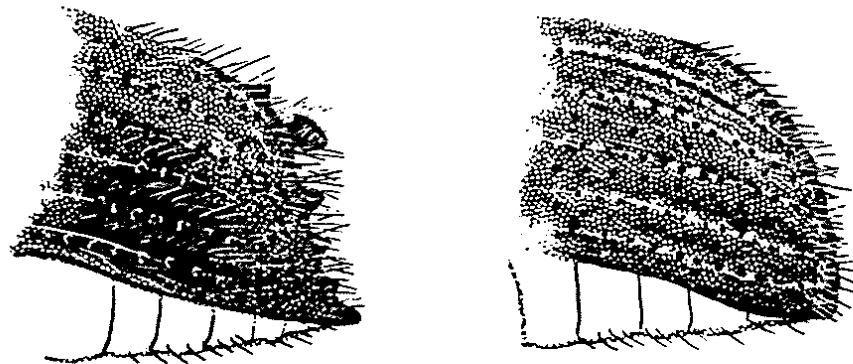


Figure 1.—Side view of hind end of *Ips* beetle (left) and southern pine beetle (right). Both greatly enlarged.

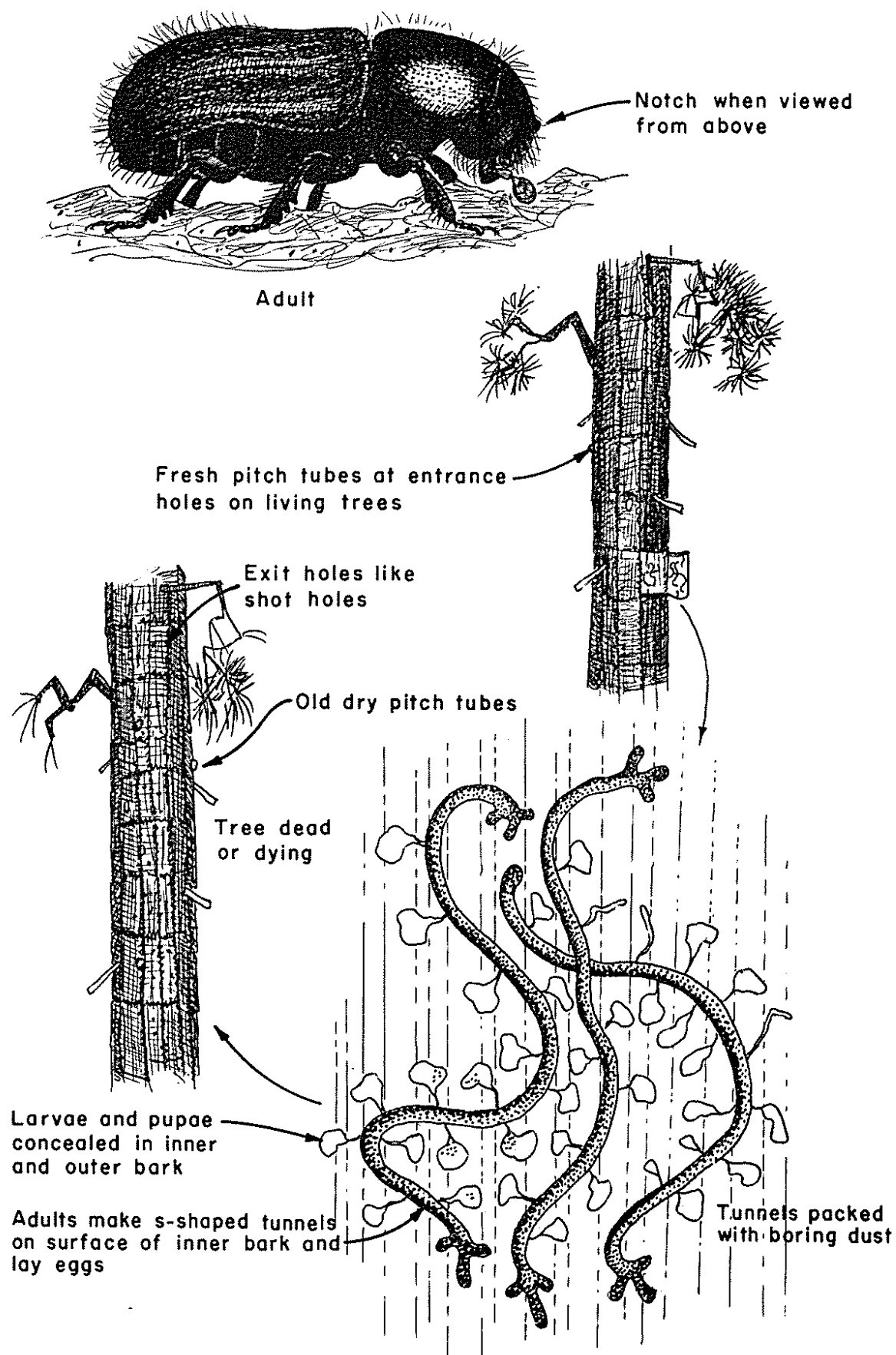


Figure 2.—Southern pine beetle.

beetles at all, and the few that do remain are generally mixed with *Ips* beetles in overmature, suppressed, or lightning-damaged trees.

Signs of attack.—The first sign of infestation usually is fading of the tree crowns. Needles become yellowish and soon turn reddish brown. Infested trees have whitish or yellowish pitch tubes, about as large as a pencil eraser, scattered over the bark. In trees of low vigor, pitch tubes may be small or lacking but reddish boring dust will be seen in bark crevices and in spider webs on the lower trunk. Removal of the outer bark will expose the characteristic S-shaped tunnels.

In summer, new broods may leave the trees when the foliage is only slightly faded. When crowns turn red, the beetles have usually left. But in winter, infested trees may be found in any stage of crown coloration, from green to red. When overwintering brood trees remain green, woodpecker work in the upper stem—where beetles tend to concentrate in the cool months—may provide the best clue to the insect.

Control.—The most realistic approach to avoiding timber losses by bark beetles is to manage stands with an eye to vigor and to sustained good growth. Stand density should be tuned to tree species, composition, site, and soil moisture conditions. On sites subject to frequent or prolonged flooding, improvement of surface drainage is beneficial. Severe stand disturbance by logging, road construction, and other human activities should be avoided.

Salvage logging will check outbreaks only if all of the infested bark is removed from the woods or destroyed before the beetles emerge. This can best be done in the cooler months, when beetle activity has slowed. In planning any salvage, it is important to understand that the beetles' attack pattern upon the tree may change seasonally. In the deep South, for example, the insect infests the lower stem from spring until fall and the middle and upper stem in the cooler months. On mild winter days, beetle broods may continue to develop, emerge from the bark, and reinfest unoccupied portions of the same tree or adjacent trees. By spring, brood concentrations may become so great that each tree is at least 10 times more heavily populated than in summer. In winter and spring operations, therefore, tops must be utilized or piled and burned, otherwise up to one-third of the beetles may escape. Infested unmerchantable trees and large bark slabs knocked off in felling and skidding should also be destroyed.

The general strategy of control is to keep ahead of the insect by first salvaging trees that still have broods in them. **Do not make the mistake of concentrating on dead, vacated trees in summer, or of neglecting infested red-topped ones in winter.**

IPS. ENGRAVER BEETLES

Ips avulsus, *Ips grandicollis*, and *Ips calligraphus*

The three common species of *Ips* bark beetles kill sapling and larger pines that have been weakened by drought, fire, hail, windstorms, or other causes. Lightning-struck trees, logs, and logging slash are especially attractive to them. Infested trees are typically scattered through the forest, but each year activity increases with the advent of hot, dry weather in summer and fall. Infestations in single trees often pass unnoticed even though the cumulative damage, month after month, is high. After extended droughts, however, beetles may kill groups of trees and reach alarming proportions. As with the southern pine beetle, damage is accentuated by a blue-stain fungus that the adults carry.

Habits.—Young adults are tan; older ones are reddish- to dark-shiny brown. They differ from the southern pine beetle and black turpentine beetle by having a shovel-shaped hind end bordered by minute tooth-like projections (fig. 1). Adults construct egg tunnels between the inner bark and sapwood. Eggs are deposited in distinct niches along the sides of the tunnels. The larvae—white, legless, and with brown heads—chew slender mines outwards from the main tunnels and girdle the tree. Transformation from larva to pupa, and from pupa to adult, takes place in an oval cell at the end of each larval mine. Young adults chew round exit-holes through the bark and fly to host trees in the vicinity.

Although similar in appearance and behavior, the three *Ips* species are unlike in size and generally prefer different parts of the tree. *Ips avulsus*, the smallest species, is not quite 1/8-inch long. It attacks the upper stem and crown and sometimes the entire trunk of trees of all sizes. It is potentially the most dangerous southern *Ips*, since it tends to invade weakened pines that might otherwise survive. Populations normally build up in fresh slash from summer logging and spread to nearby crowns when cutting ceases, particularly if trees have been weakened by drought, competition, or age. When this happens, *avulsus* activity may make stands more susceptible to the southern pine beetle. *Avulsus* sometimes shows unusual aggressiveness, and landowners should not underrate it. Its presence in the crowns may not be noticeable except to an experienced spotter or with the aid of binoculars.

The medium-sized *Ips grandicollis* is about 3/16-inch long and is usually found in the mid-stem area. *Ips calligraphus*, the largest species, is 1/4-inch long. It commonly attacks the thick bark of the lower trunk. Both species, however, sometimes occur on any part of the trunk and larger branches.

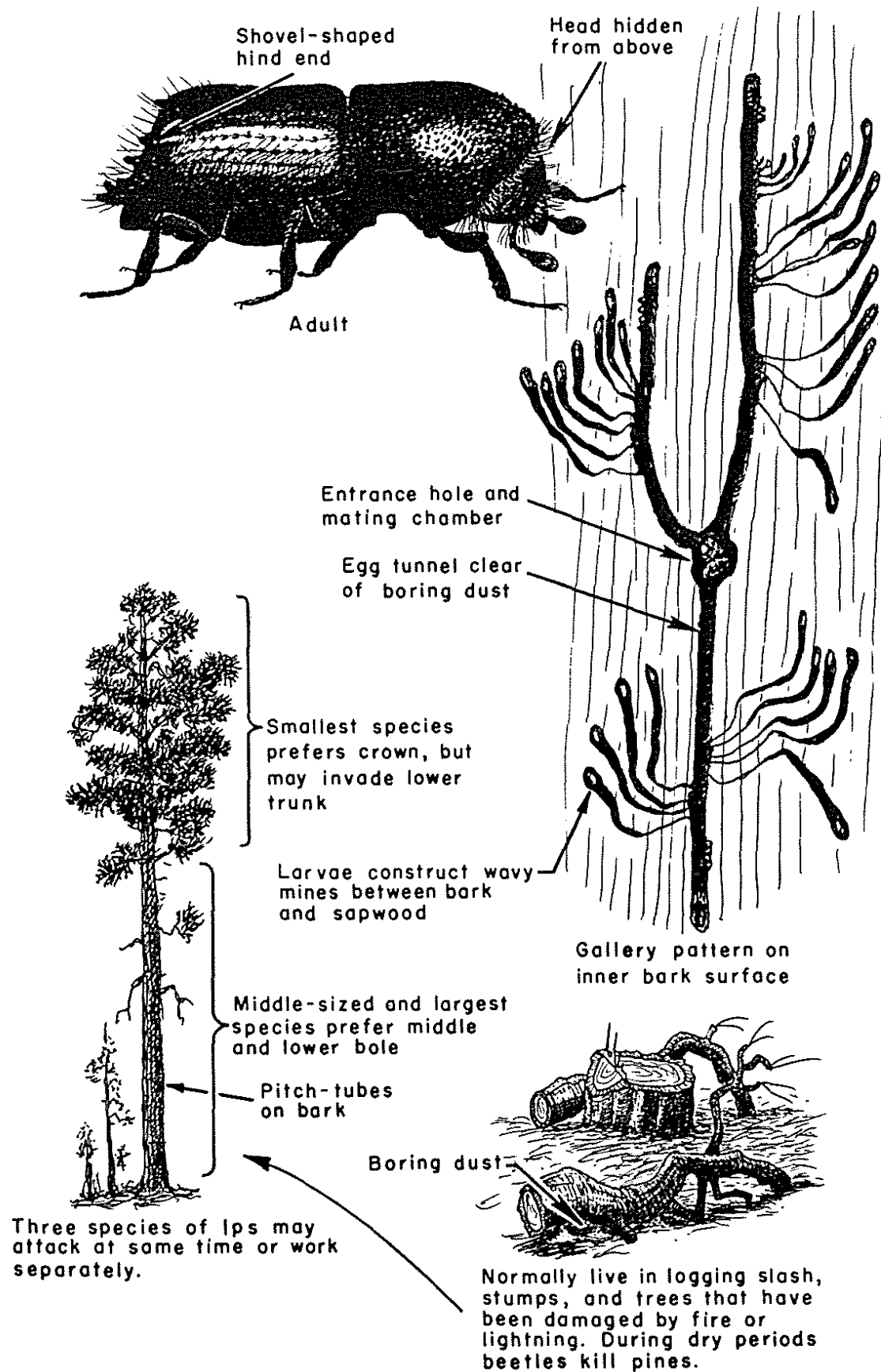


Figure 3.—*Ips* engraver beetles.

The three species may work together in the same tree, their zones of occupation overlapping, or they may work independently or in succession. They may also become associated with the southern pine beetle, black turpentine beetle, and pine sawyer beetles. There are a number of overlapping *Ips* generations each year.

Signs of attack.—Infested trees will usually have numerous pink or reddish-brown (occasionally whitish) pitch tubes, about the size of a wad of gum, on the bark of the trunk. In trees of low vigor, however, pitch tubes are usually lacking, and earliest signs of attack will be reddish boring dust in bark crevices and on spider webs at the tree base.

If trees are infested by *avulsus* alone, external symptoms of attack may be lacking and the foliage may still be green or only a trifle faded when the broods begin to leave. Broods of the two larger *Ips* species, however, are often present after the trees have reddened. Sometimes the trees turn yellow or red, limb by limb.

The egg tunnels, engraved on the inner bark and surface of the sapwood, are more or less straight and run parallel to the grain. They are Y- or H-shaped, each of the three or four arms being made by a different female. With the aid of their shovel-like bodies, the several females and their one male mate keep the tunnels free of boring dust. Larval feeding mines—slender, wavy, and packed with boring dust—lead from the egg tunnels.

Control.—*Ips* beetles usually are most troublesome in poorly managed stands. As with the southern pine beetle, therefore, the best preventive is to keep the trees growing vigorously.

In most years, *Ips* attacks are restricted to dead, dying, and weakened pines scattered throughout the forest. Recognizing the chronic nature of infestations and the potential for their spread, some timber owners have developed workable year-round salvage programs to remove lightning-struck, declining, and other susceptible trees that serve as breeding places. Should populations develop to outbreak proportions, equipment is concentrated in critical areas to remove most of the dead timber before sawyer beetles, termites, and other agents render it unmerchantable.

During summer harvesting or salvage operations, large numbers of beetles, particularly *avulsus*, may develop in the slash and threaten standing timber. The hazard is especially great if intermittent partial cutting is done during hot, dry weather. When cutting ceases, beetles may leave the slash to attack surrounding trees. Slash produced during the last 2 or 3 weeks of cutting should be limbed, scattered, and exposed to the sun or piled in windrows and burned. Such treatment will kill developing broods.

If severe and widespread epidemics follow drought, hurricanes, or other natural disturbances, little can be done except to remove and utilize infested merchantable material before it deteriorates. Soaking rains, especially in winter, will usually stop the epidemic. Following severe hurricane damage, however, outbreaks may continue for a year or two.

BLACK TURPENTINE BEETLE

Dendroctonus terebrans

The black turpentine beetle is a serious and persistent pest capable of killing the best trees in a stand. It is especially abundant after heavy cutting, wildfire, drought, windstorms, and other disturbances. Skinned and bruised trunks and roots account for its prevalence in logging areas. Such injuries are particularly numerous following wet-weather logging on low, poorly drained sites. In naval stores areas, intensively worked trees are very susceptible to attack.

Habits.—The robust, brownish-black to black beetles are $\frac{1}{4}$ - to $\frac{1}{3}$ -inch in length and are readily attracted to the odor of resin emanating from skinned, bruised, or severely scorched bark. They bore into the cambium near the base of injured, dying, or apparently healthy trees, and also invade fresh stumps and larger roots. Each pair constructs a vertical, longitudinal tunnel, several inches to a foot long. Eggs are laid in elongate masses along one or both sides of the tunnel. The larvae are white, with brown heads, and legless. They feed in groups and excavate an inner-bark cavity of 1 to 2 square feet in area. When fully developed, they pupate in conspicuous oval cells within or adjacent to their feeding area. The adults emerge from the bark through BB-size exit holes.

If attack is light the trees usually survive. When broods are numerous they girdle the cambium and the tree slowly dies.

Populations are most likely to build up in fresh stumps and then spread to nearby living trees. But on occasion, the beetles may invade stumps and trees at the same time, or infest trees mostly, with only limited attacks on stumps. There are two or three overlapping generations annually in the Midsouth. All life stages may be found throughout the year.

Signs of attack.—Obvious signs of attack are large pitch tubes on the lower trunk, on exposed roots, and sometimes on stumps. The tubes are about the size of a walnut and whitish, reddish, or purple-gray. Older tubes have a sugar-like structure. When beetles are at work, granular pieces of hard, white resin, about the texture of coarse sand, will be found in bark crevices below the pitch tubes or around the rootcollar. The tunnels and irregular excavations in the inner bark are filled with sticky resin and red boring dust. Sometimes attacks are confined to the stem below the rootcollar and can be detected only by scraping away the duff from the tree base. If pitch tubes are lacking, granular particles of resin will be the only external symptom.

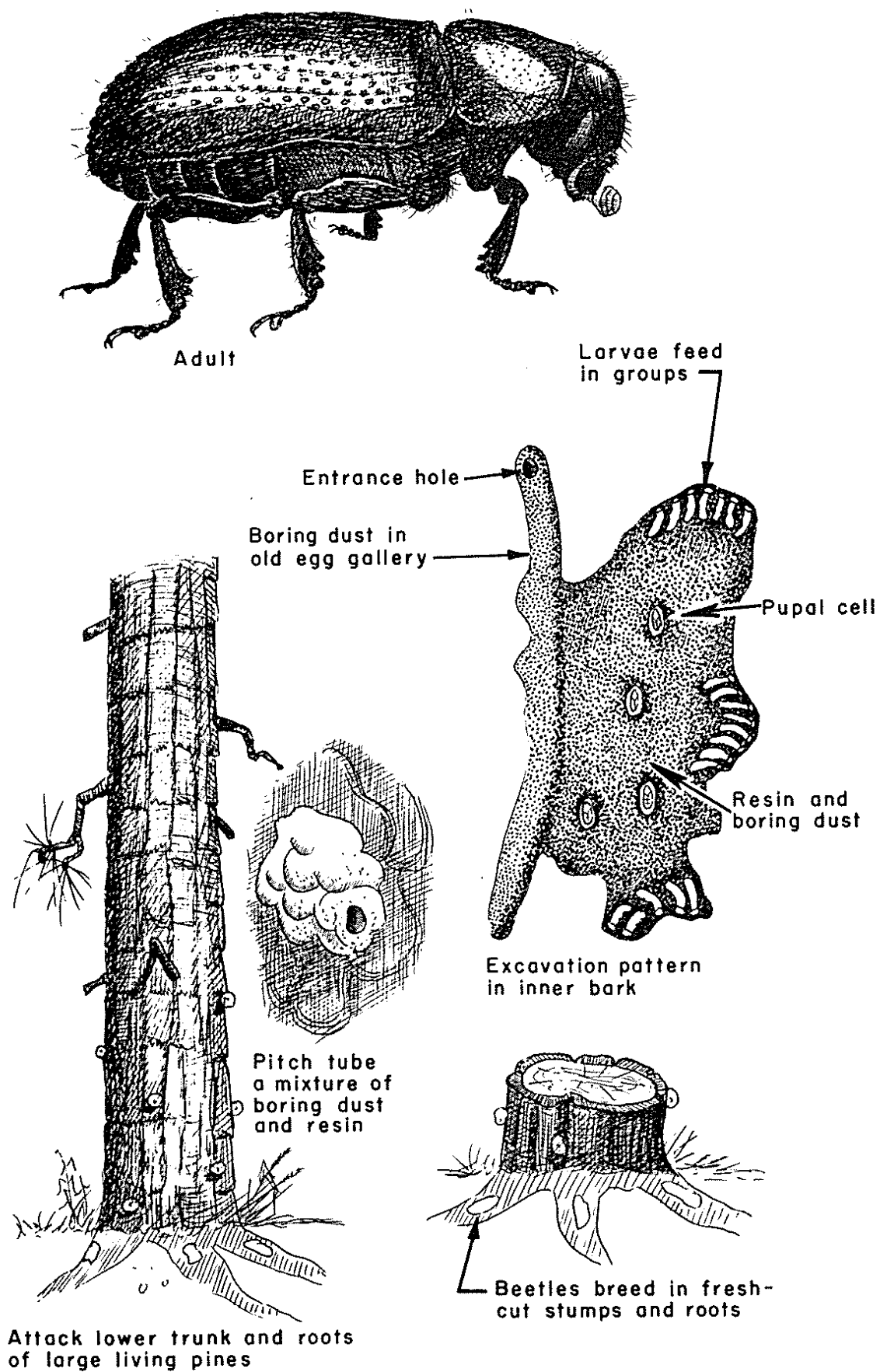


Figure 4.—*Black turpentine beetle.*

Ambrosia beetles invariably attack trees that begin to die, even while the crowns remain green. Their presence is indicated by fine, whitish boring dust which accumulates in piles on bark scales and on the ground around the tree.

Foliage color is not a satisfactory clue to turpentine beetle activity, for heavy populations may develop before the trees are killed.

Control.—Outbreaks are especially likely when sites are severely disturbed by heavy logging equipment and where timber is removed at intervals of several months. Thus, when successive cuts are made for poles and piling, sawtimber, and finally pulpwood and hardwoods, beetle populations increase steadily as each new generation is provided with an abundance of fresh stumps and damaged trees. The repeated disturbances to the soil and roots, as well as the relocation of woods roads, further weaken the residual stand, alter water tables, and provide ideal conditions for beetle attack. When cutting is terminated and fresh stumps are no longer available, emerging beetles kill the weakened trees by force of numbers.

Buildup of populations is comparatively slow, and with a little care the susceptibility of residual trees can be substantially reduced. Logging should be planned so as to minimize damage to the site and to remaining trees. Wet-weather logging should be avoided on poorly drained sites, woods roads should be made wide enough so that trucks and tractors will not skin trees along the sides, and trees damaged during harvests should be salvaged.

If these precautions are not taken, the timber manager must be prepared to accept the consequences. When an outbreak develops and valuable trees are at stake, the first matter of importance is to decide which trees may survive attack and which should be marked for salvage. While lightly infested trees will generally survive, the fate of heavily infested ones is difficult to predict. Timely rains sometimes enable severely weakened trees to recover, while extended dry spells may cause the death of trees only slightly damaged by the beetle. The number of pitch tubes does not necessarily indicate the probability of tree mortality, because many attacking beetles are pitched out or fail to develop broods. Also, pitch tubes may persist for months after broods have left the tree, giving a false impression of the number of beetles actually present. The most positive guide for deciding when a tree should be cut for salvage is the presence of ambrosia beetle dust at the tree base. Usually, but not always, the tree will die when this light-colored, powdery material is present around most of the trunk.

SOUTHERN PINE SAWYERS

Monochamus titillator and *M. carolinensis*

During the warm months weakened, dying, and dead pines are invariably attacked by pine sawyers of two species. The larvae tunnel through the sapwood and heartwood, degrading the lumber and opening the way for decay fungi. Sawyers are particularly destructive to windthrown timber, to trees damaged by wildfire, lightning, or bark beetles, and to saw logs and pulpwood left in the woods or held too long in storage. Such timber may be rendered worthless if salvage and milling are delayed a month or more after initial infestation by sawyers.

Habits.—The two species are alike in appearance and habits. The adults are mottled, grayish-brown, and $\frac{3}{4}$ to $1\frac{1}{4}$ inches long. They are commonly called long-horned beetles, because their antennae are sometimes much longer than the body. For depositing their eggs, females cut circular, funnel-shaped pits about $\frac{1}{5}$ -inch wide in the bark surface. The larvae are legless, slightly flattened white grubs, which eventually reach a length of about 2 inches. The thoracic or front segments of the body are slightly wider than the abdominal segments. At first, the larvae feed between the inner bark and sapwood. Later they invade the heartwood where they chew oval holes up to $\frac{1}{2}$ -inch in width. Eventually they return almost to the surface in U-shaped tunnels, at the ends of which they make pupal cells. After transformation, each adult cuts a hole through the bark and escapes. There are two or more overlapping generations each year in the South.

Signs of attack.—The earliest signs of attack are the conspicuous funnel-shaped egg niches in the bark. Beneath the bark, dense brownish borings and coarse-shredded, whitish excelsior-like wood shavings are present. Both the boring dust and the shredded material usually exude from cracks in the bark and fall to the ground in piles around the tree. The rasping or gnawing noise made by the larvae can be heard for a considerable distance. Round pencil-size holes through the bark are a sign that the adults have emerged.

Control.—Rapid removal and utilization of dead and dying trees or green logs will prevent or greatly reduce sawyer damage. Logs or bolts may be stored indefinitely by submerging them in water, or they can be held for at least 6 months in piles under continuous water spray. Pulpmills may also curtail sawyer activity by peeling bolts or chipping the wood before storage.

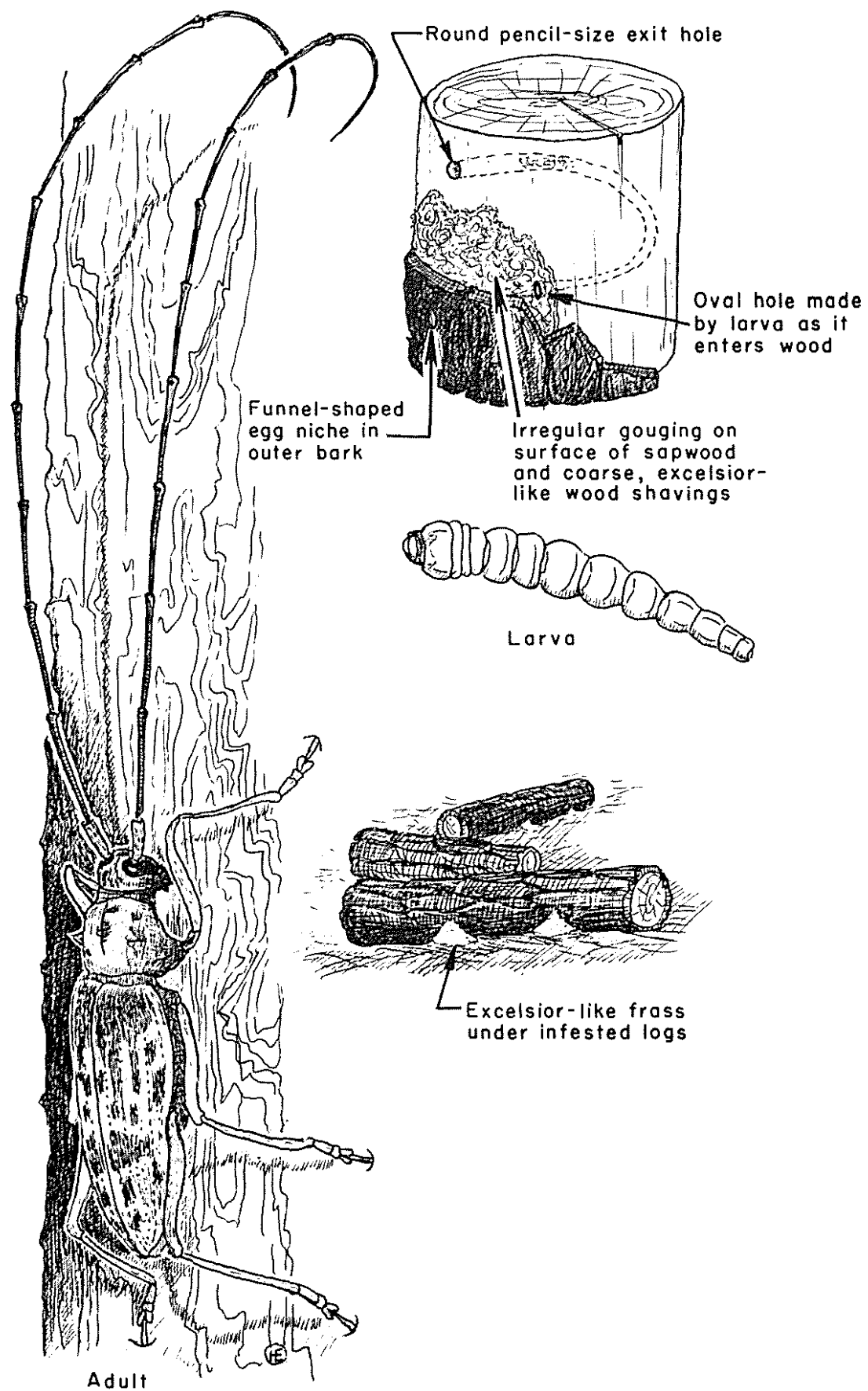


Figure 5.—Southern pine sawyers.

TURPENTINE BORER

Buprestis apricans

The turpentine borer was once a major problem in naval stores orchards, but improved operating practices have significantly lessened attacks. The insect is still occasionally destructive, however, to longleaf and slash pines that have been scarred by fire or injured by logging. Damage is caused by the larvae, which riddle the sapwood and heartwood with pencil-size holes. When infestations are severe, 3 to 6 feet of the butt log may become unfit for lumber, and frequently the weakened stems snap off in windstorms. Sound healthy trees are seldom attacked.

Habits.—The beetle is 1¼-inches long, grayish-bronze with a greenish metallic luster. There are eight longitudinal rows of pits on each front wing. The larva is a white legless grub up to 1½-inches long. Unlike the pine sawyer larva, it appears flat-headed or cobra-like because the thoracic or front segments are distinctly wider than the abdominal ones.

The female is attracted to scorched or exposed wood near the base of living trees. She lays eggs in cracks that develop as the tissue dries. The larvae honeycomb the tree by extensive tunneling in the sapwood and heartwood. About 3 years are required to complete the life cycle.

Signs of attack.—Often the earliest signs of this beetle are ¼-inch elliptical exit holes on the surface of the bark and on exposed wood near the tree base. When infested trees are broken by wind or sawn into lumber, the numerous pencil-sized tunnels are revealed. Each tunnel is filled with a characteristic cement-like plug of resin and boring dust.

Control.—Severe infestations in naval stores timber have been virtually eliminated by careful scraping of gum so as not to expose wood to checking, by prompt harvesting of worked-out trees, and by other modern turpentine practices recommended by the USDA Forest Service. However, many worked-out trees in abandoned naval stores orchards and old snags in neglected natural stands remain as breeding places.

Losses can be curtailed by removing brood trees from the forest, avoiding injury to the stand during logging, salvaging trees damaged in windstorms, and making controlled burns to reduce wildfire hazards.

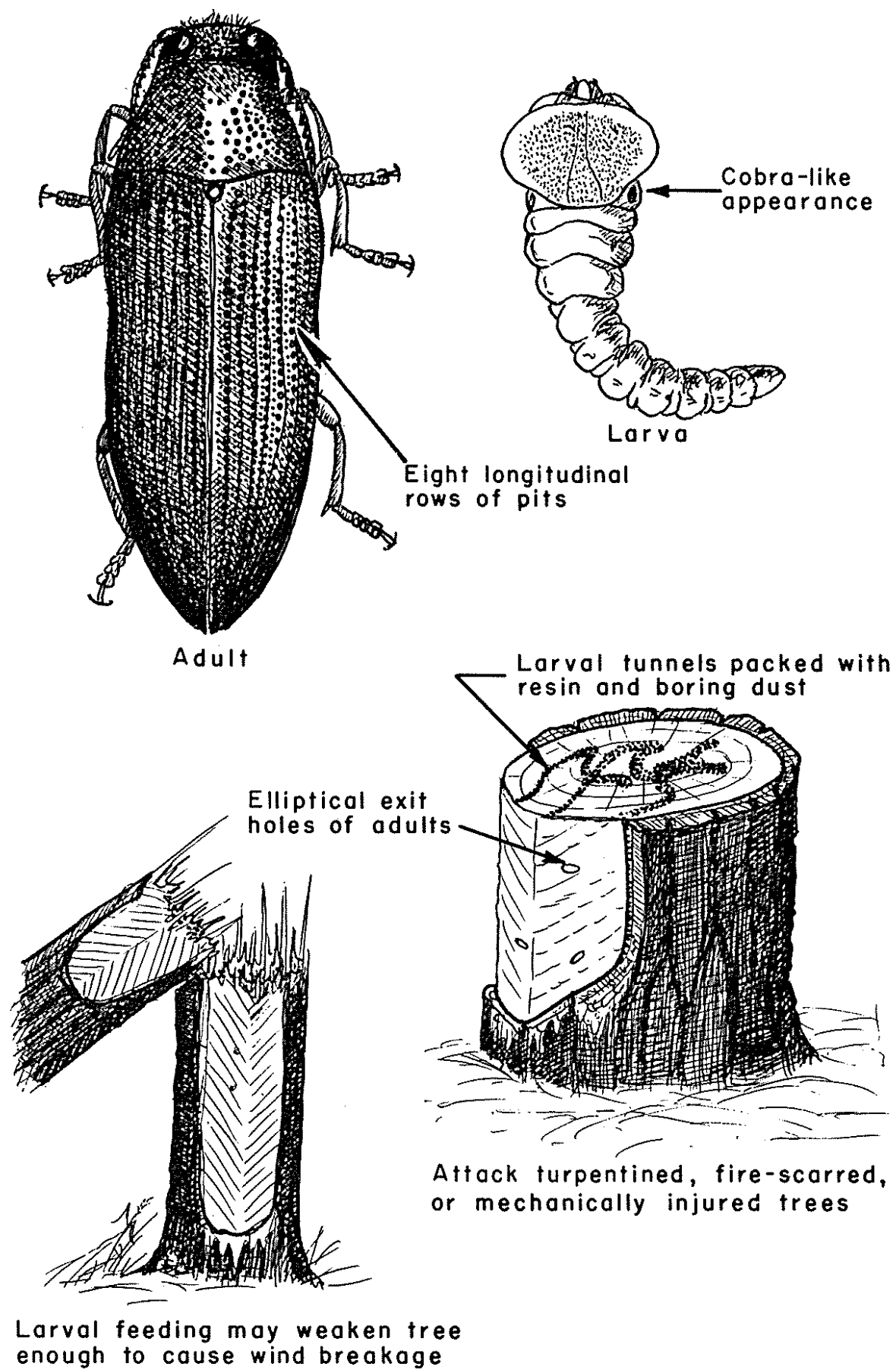


Figure 6.—Turpentine borer.

AMBROSIA BEETLES

Platypus spp.

Ambrosia beetles of the *Platypus* group bore pine-size holes into the sapwood and heartwood of dying pines, green logs, and new stumps. They commonly invade trees that are under attack by bark beetles. Known to lumbermen as flagworms, the adults carry an ambrosial fungus which penetrates the tunnel walls and leaves a dark stain. Because of the unsightly stain, material cut from infested logs is frequently worthless.

Habits.—The beetles are reddish brown, shiny, cylindrical, and about ¼-inch long. They tunnel directly into the wood to a depth of about 1 foot and deposit eggs. The larvae feed upon the fungus introduced by the adults and after about a month construct separate cradles deep in the wood and parallel to the grain. Damage is greatly accentuated by development of the stain on the cradle walls. Pupation takes place in the cradles, after which the new adults depart through the entrance holes initially made by their parents. One female may produce more than 100 progeny. There are several generations each year.

Signs of attack.—A yellowish-white, fluffy material is pushed out of the tunnels and accumulates in piles around the tree base, in bark crevices, or on the ground beneath logs. In lumber, the characteristic pinholes surrounded by black stain are easily seen.

Control.—Prompt utilization of dying trees and fresh-cut logs will reduce or eliminate losses. Kiln drying of infested lumber prevents further development of the brood and fungus. Storing fresh-cut timber in water also will prevent most damage, but some attack may be expected in the upper side of high-floating logs. Storing the logs in open water where they will receive full effects of the sun will reduce the likelihood of damage aloft.

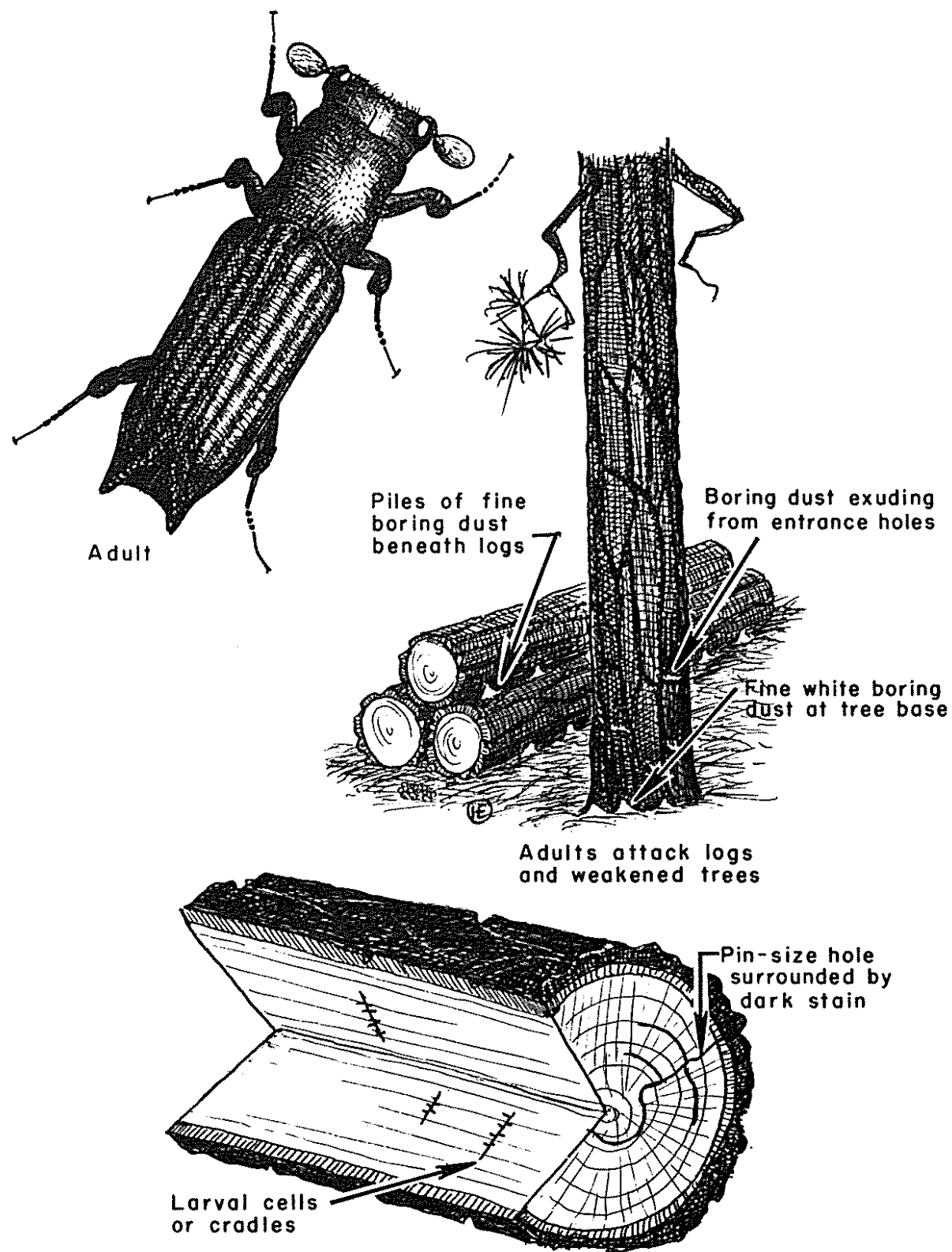


Figure 7.—*Ambrosia* beetles.

NANTUCKET PINE TIP MOTH

Rhyacionia frustrana

Tip moth larvae kill buds and twigs of young loblolly and shortleaf pines in natural stands and plantations. They are sometimes found on slash pine also, but there is no evidence of severe injury to this species. Attacks virtually cease after trees attain heights of about 10 feet. If the trees are vigorous enough to produce terminal growth faster than it is destroyed, they pass beyond the susceptible stage in a few years. On poor sites, however, severe and repeated attacks may result in stunted, deformed trees that require years to recover.

Habits.—The adults are about $\frac{1}{4}$ -inch long with a wing expanse of $\frac{1}{2}$ -inch. They are copper-colored with silvery markings on their wings. Eggs are laid on twigs and around needle bases. The larvae are yellowish to pale brown, hairless caterpillars up to $\frac{1}{3}$ -inch long. They feed within the buds and twigs and later change into shiny brown capsule-like pupae. The insect spends the winter mostly in the pupal stage in hollowed out twigs. The moths appear about the time pines begin their spring growth. There are several generations each year and as the warm season advances generations tend to overlap.

Signs of attack.—Terminals and branches of infested pines have many brown, dead buds and stunted, curled, or gnarled twigs. A crust of hard, whitish resin usually appears between the buds, needles, and twigs; and the insides of the dead buds and twigs are hollow except for granular particles of excrement. The foliage becomes yellow when first attacked, then turns red, and finally brown.

Control.—The insect is so widespread that few forest nurseries or young stands are free of it. Before outplanting, seedlings should be inspected and injured buds and twigs destroyed. Infested material should be pruned well below the dead part, because larvae normally feed in the green tissue below. In areas with a history of heavy infestation, planting of loblolly and shortleaf pines should be avoided except on sites most suitable to quick growth. Anything that will encourage rapid development, such as vigorous tree strains or ideal sites, will help to reduce damage. Heavily infested seedlings on barren soils along roadside fences are common throughout the South. If close to young plantations, such trees serve as focal points for spread and should be cut and burned.

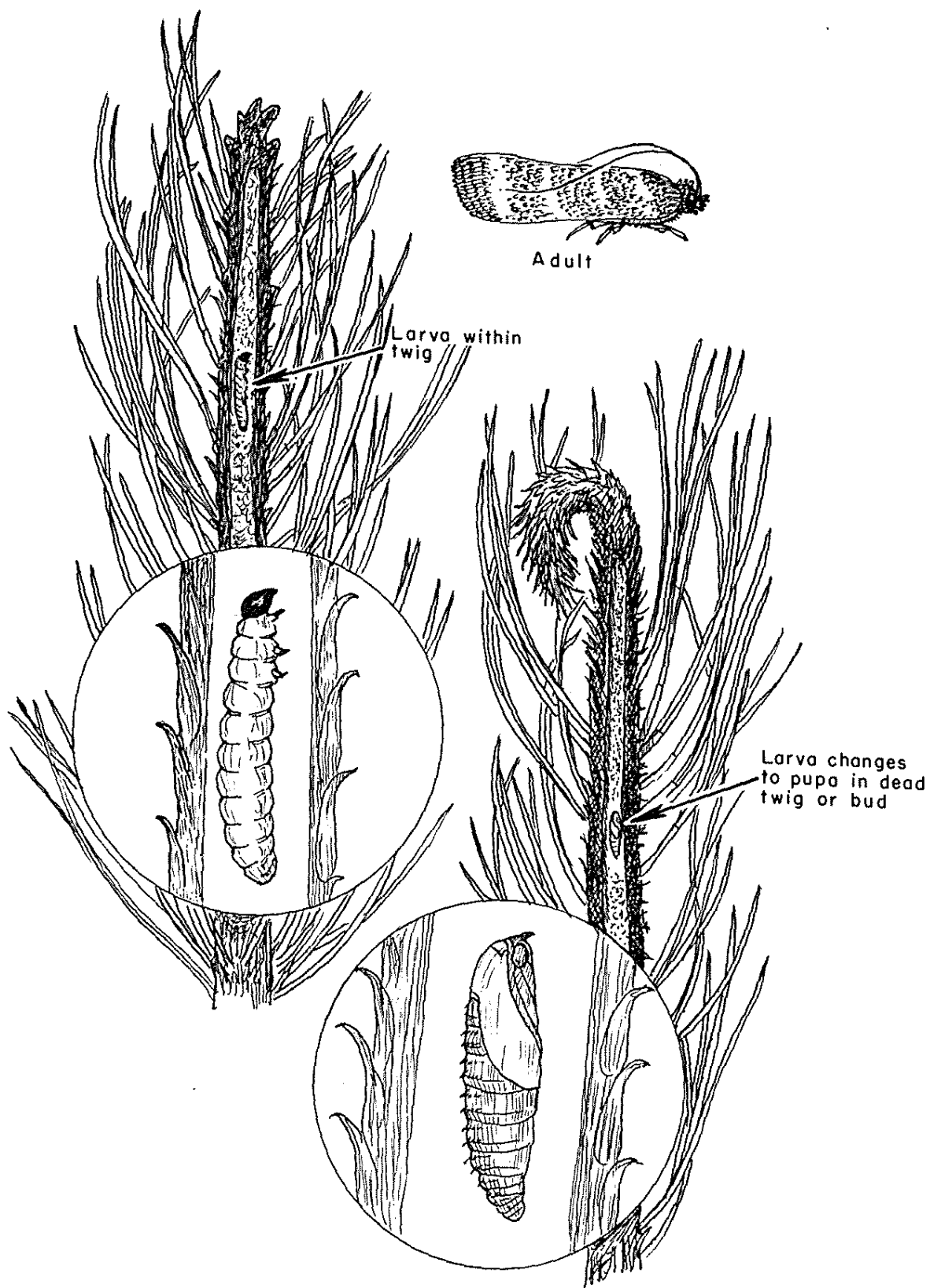


Figure 8.—Nantucket pine tip moth.

PINE WEEVILS

Hylobius, *Pachylobius*, and *Pissodes* spp.

Adults of the pales weevil (*Hylobius pales*) and the pitch-eating weevil (*Pachylobius picivorus*) are attracted to stumps and dying trees, where they deposit their eggs. They feed upon and destroy seedlings in the vicinity. The deodar weevil (*Pissodes nemorensis*)¹ normally breeds in the main stem of dying pines and, therefore, has been of little consequence. But in recent years the insect has aroused concern because of its tendency to infest leaders of apparently healthy saplings and to destroy seedlings weakened by almost any cause. The three weevils have become important in the South as increasingly large acreages are clearcut and planted.

Habits.—Weevils are robust, hard-shelled beetles characterized by a rigid and prominent snout with minute chewing mouthparts at the tip. The pales weevil and pitch-eating weevil look much alike. Adults are black or nearly so, and often speckled with whitish markings. They are 1/4- to 1/3-inch long. The *Pissodes* weevil is slightly less than 1/4-inch long and is a rusty-red with two distinct whitish blotches on the back.

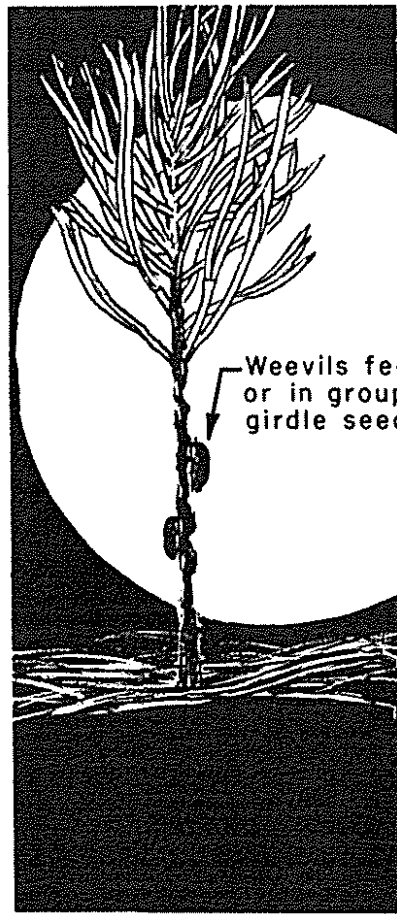
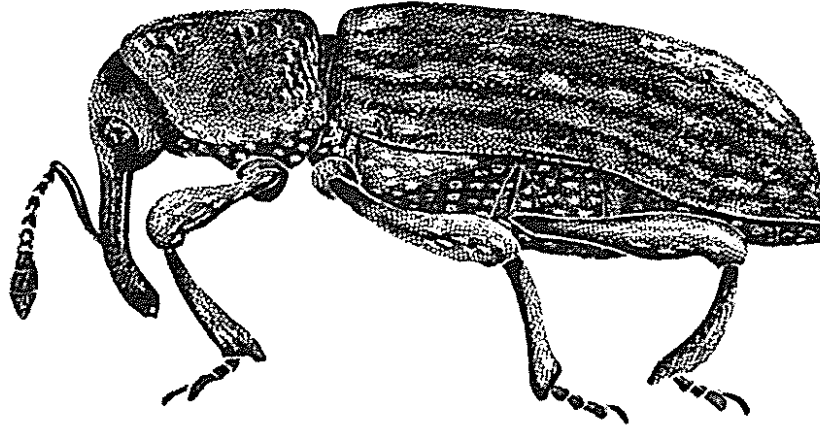
Females of the three species place their eggs in small holes chewed in the bark. The larvae are small, white, and legless, with shiny brown heads. They make separate winding tunnels between the inner bark and sapwood. When fully grown, each larva constructs a conspicuous, oval "chip cocoon," 1/3-inch long, of finely shredded sapwood. Here it pupates and then, as a young adult, chews a round, BB-size exit hole through the cocoon and bark.

Most damage by the pales and pitch-eating weevils occurs in spring and fall. The adults are attracted to the odor of freshly cut pine stumps, scorched pines, or dying trees and feed on the tender bark of nearby seedlings. Eggs are deposited in the root bark of stumps and trees and infrequently in the bark of logs. Larvae feed in the cambium of the stump and roots and are of no economic importance. The new adults may feed on seedlings before flying to other cut-over or recently burned stands.

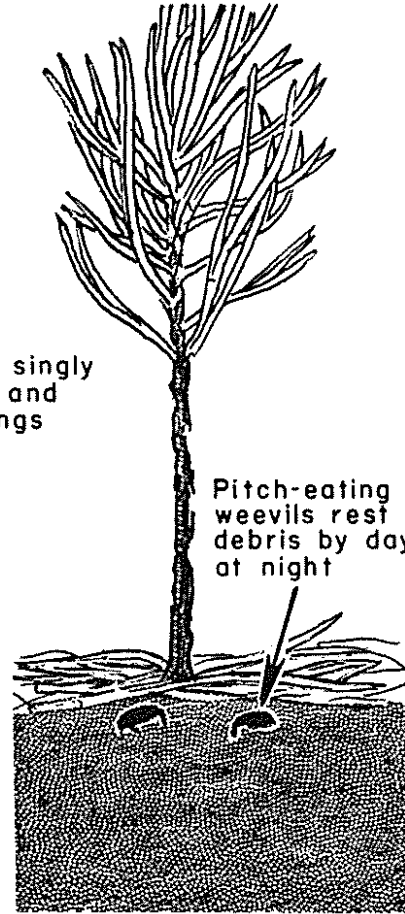
Pissodes is most common in natural stands and plantations, where it breeds beneath the bark of saplings and larger pines that are dying from competition, suppression, or bark beetle attack. But on occasion it attacks young seedlings that are growing on poor sites or have been weakened by improper planting, erosion, or moisture stress. The seedlings may be killed by the larvae

¹ Species of the genus *Pissodes* are extremely difficult to separate. What we now know as *nemorensis* may be a complex that someday will be broken down into several subspecies, or even species.

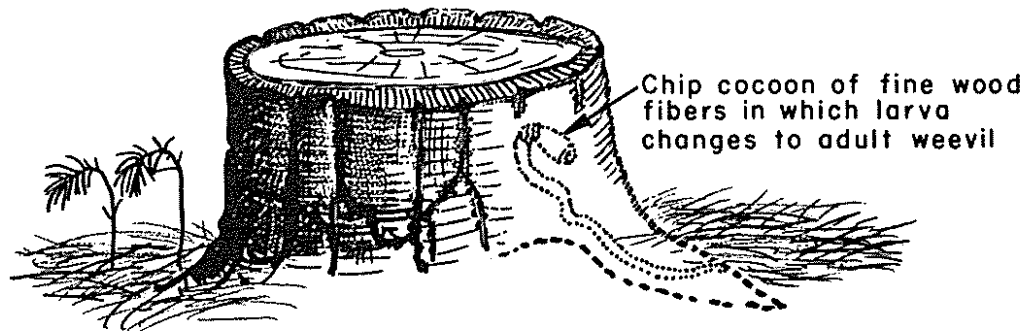
Typical weevil adult



Weevils feed singly or in groups and girdle seedlings



Pitch-eating and pales weevils rest in surface debris by day and feed at night



Chip cocoon of fine wood fibers in which larva changes to adult weevil

Figure 9.—Pine weevils.

tunneling in the cambium and woody tissue, or by multiple bark punctures caused by adult feeding. Young pines defoliated by sawflies may also attract the weevil, and sometimes the insect breeds in the leaders of apparently healthy field-grown trees, especially loblolly and shortleaf pines 10 to 20 feet high. Repeated killing of the terminals creates flat-topped or stag-horned crowns.

Signs of attack.—Adults of the pales and pitch-eating weevils typically girdle the bark around and below the rootcollar of 1-year-old and older seedlings. They may also eat patches of bark anywhere on the stem and branches. The seedlings suddenly wither and die. If the insects are abundant, they may remove all of the bark and foliage, leaving only yellowish, pencil-like stubs protruding from the soil. The weevils feed at night and are most active in the spring and fall. By day, they may be found in litter or soil near the damaged seedlings.

First symptoms of *Pissodes* damage are wilting and dying seedlings or drooping, sometimes spike-like leaders of pine saplings. Close examination of infested bark will reveal pin-size egg niches and sometimes larger, irregularly shaped feeding punctures made by the adults. Removal of the bark will disclose the larvae in their tunnels or the characteristic "chip cocoons" partly imbedded in the sapwood. Unlike the other southern pine weevils, *Pissodes* feeds during the day and is active throughout the growing season.

Control.—In the Gulf Coastal Plain, losses to the pales weevil or pitch-eating weevil should be minor when at least 6 months elapse between cutting of the old stand and planting of the new one. By this time the pine stumps will have aged enough to lose their attractiveness. Thus sites where pines have been cut earlier than July may be planted safely the following winter. Pines that seed in naturally are also damaged, but it takes them about a year to reach sizes liable to weevil attack. Therefore if regeneration cuts are made concurrently with seedfall or if direct seeding is done shortly after cutting, the reproduction should escape with only minor damage during the first season from seed. By the time the seedlings are in their second season, the stumps of the cut pine should no longer be attractive to the weevils. But where fairly heavy cuts are made in stands supporting seedlings 1 or 2 years old, damage should be anticipated. It may be worth delaying the cut for a year to allow the seedlings to reach a less susceptible size.

Trouble from *Pissodes* weevils can best be avoided by the prompt removal and disposal of suppressed and dying pines, and by planting seedlings on good, well-drained sites, and at the correct depth and with roots properly positioned.

WHITE GRUBS

Phyllophaga spp.

White grubs, the larvae of common May or June beetles, damage seedlings that have been planted in abandoned fields or on sod. They are sometimes a threat to seedlings in experimental plots or to grafted stock in seed orchards. It is likely that grubs cause some of the mortality laid to drought or vegetative competition.

Habits.—The large, heavy-bodied adults appear in the spring and damage the foliage of pines, oaks, and many other hardwoods. There are about fifty species in the South, and the different kinds show preferences for certain hosts. Trees that are fed upon by the adults are seldom killed, but the mutilated leaves of woodland, park, and shade trees may cause considerable concern.

Females burrow into the soil of idle land a short distance from the stripped trees and lay their eggs in a cavity several inches below the surface.

The grubs feed chiefly upon the roots of grasses, weeds, and other plants, but also destroy the roots of planted or direct-seeded pines that may be present. Young grubs nibble rootlets and root tips; older larvae girdle or devour larger roots and sometimes clip off the taproot. Seedlings less than 2 years old are most likely to be killed. Older seedlings usually survive attack, but if they are severely weakened they may succumb to drought. When grubs become an inch or so in length, each forms an egg-shaped earthen cell and pupates. In the spring, the young adults break out of the cells and dig their way to the soil surface. The life cycle is 1 to 3 years, depending upon the species.

Signs of attack.—Affected seedlings droop and turn yellow or brown. On heavily infested sites, one-third or more of the pines may be lost. Since the grubs remove most of the roots, seedlings can easily be pulled from the soil. The clipped roots and bare patches on the surface of the remaining root system provide further evidence. The grubs—plump, six-legged, with brown heads and curled white bodies—can usually be found in the soil near damaged seedlings. Large numbers of beetles attracted to lights in the spring may indicate trouble later the same year or a year or two following.

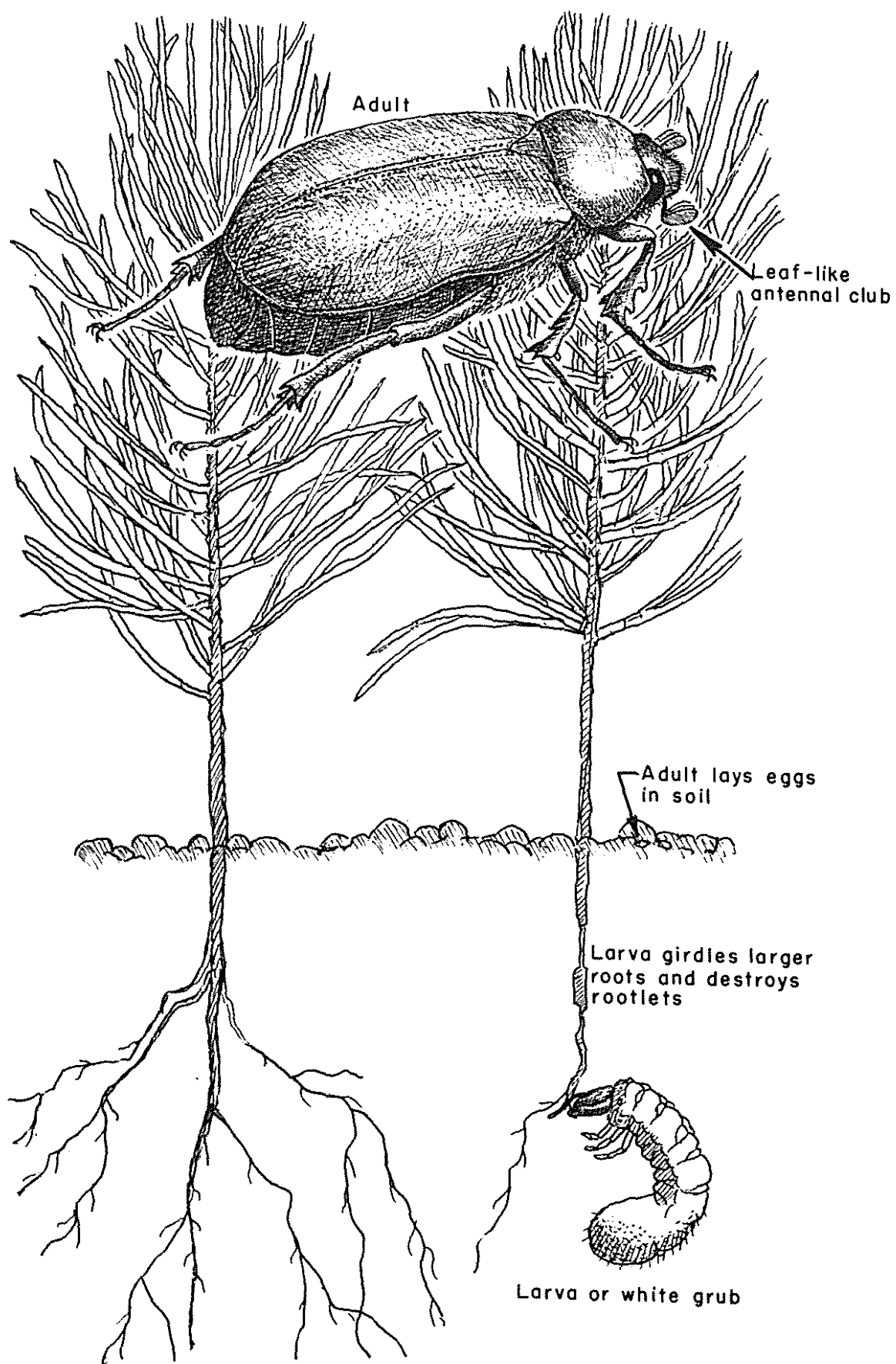


Figure 10.—*White grubs.*

Control.—Once trees are planted in grub-infested soil, control is impractical. It is a good precaution, therefore, to sample the soil to determine if a grub problem exists. In particular, heavy populations should be suspected in better soils with good sod cover.

Sampling is done by randomly turning over soil with a spade and breaking it apart to expose the grubs. Because the insects are easily detected in late summer, sampling should be done in July or August of the season before planting is anticipated. In general, populations averaging two or more grubs per cubic foot of soil may cause heavy seedling mortality. Even if the average is only one per cubic foot there is a potential for trouble.

Infestations may be reduced by plowing furrows in 4-foot-wide strips far enough apart to conform to the tree spacing desired. Furrows should be deep enough to destroy the sod cover, and to expose but not bury the topsoil. The depth may be 3 inches or more, depending upon the site. Furrowing is best done in August, when many exposed larvae will be killed by the sun's heat and by drying of the turned-over soil. Others will starve or be destroyed by birds and other natural enemies. This procedure should protect seedlings from serious damage during the several years that they are most susceptible.

PINE SAWFLIES

Neodiprion spp.

Sawflies of some eight species defoliate southern pines, but the most frequently encountered are the red-headed pine sawfly (*Neodiprion lecontei*), the so-called loblolly pine sawfly (*N. taedae linearis*), and the sawfly *N. excitans*. All have caterpillar-like larvae that chew the needles of pines of various sizes. When outbreaks develop, trees on hundreds or occasionally thousands of acres may be defoliated. The trees may suffer a reduction in diameter growth, but they usually recover within a year or two. Severe infestations in young plantations will stunt or malform trees, and repeated stripping will sometimes kill them.

Habits.—Sawfly larvae are about $\frac{3}{4}$ -inch long and hairless, but each species shows characteristic variations in color, host preference, and seasonal behavior. The most common and widespread species is the red-headed pine sawfly. It attacks young planted and direct-seeded loblolly, slash, longleaf, and shortleaf pines. The conspicuous larvae have red-brown heads and yellow abdomens dotted with longitudinal rows of black, leopard-like spots. This sawfly may have several generations annually and sometimes kills seedlings and small saplings by repeated defoliation.

Larvae of the loblolly pine sawfly feed upon sapling and older pines in natural stands. They have chestnut-brown heads and a grayish-green abdomen lined with alternating light and dark stripes. In Arkansas and Louisiana, loblolly pine is the favorite host. In Missouri and Illinois, shortleaf pine is preferred. There is one generation annually, the larvae stripping foliage in March and April only.

N. excitans occurs in natural stands throughout the South and generally attacks scattered single or small groups of pines. On occasion, however, several thousand acres of forests have been defoliated in Texas and Florida. The larvae have black heads and olive green bodies with variable and indistinct longitudinal stripes. Four to five generations may develop each year, with considerable

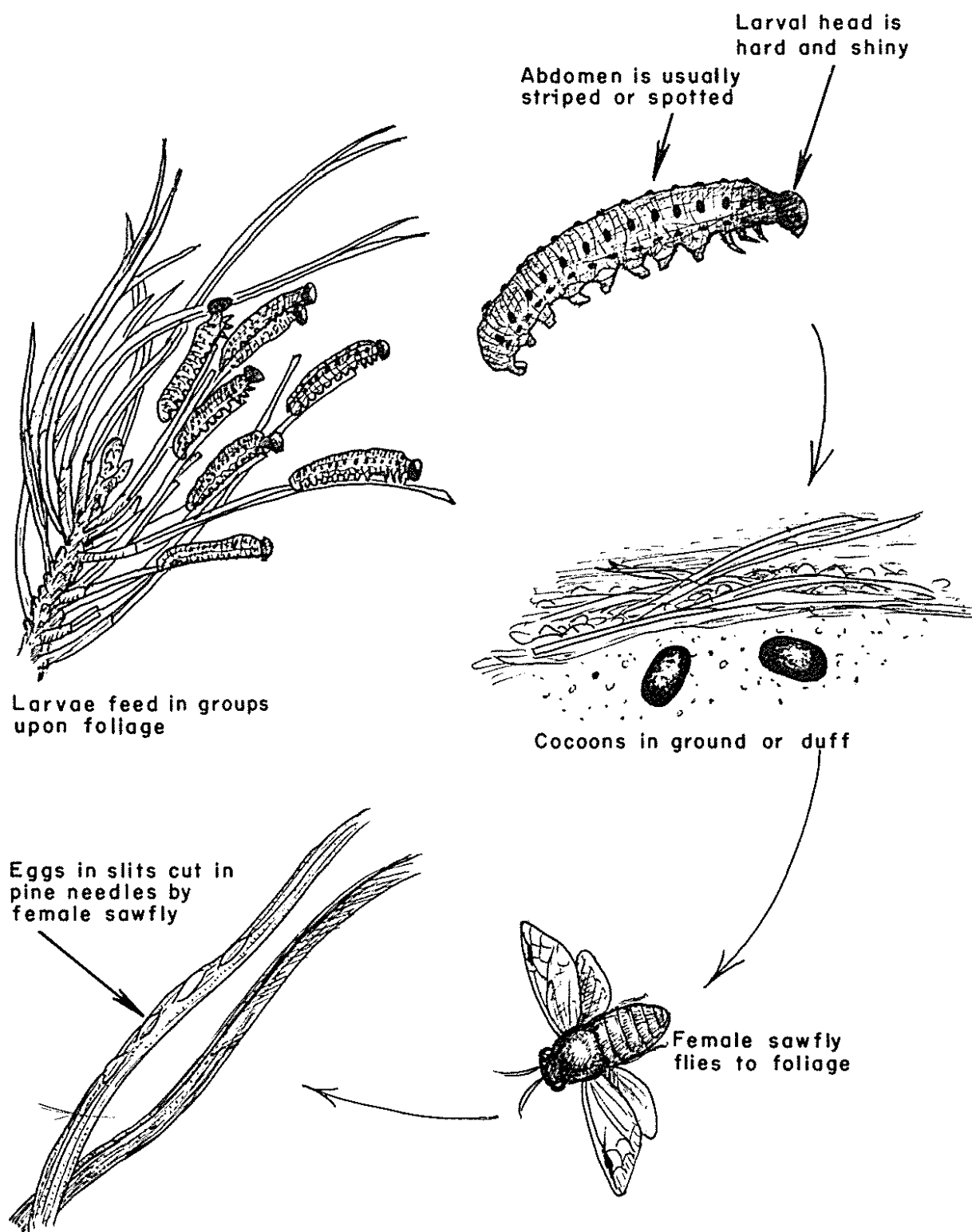


Figure 11.—*Pine sawflies.*

overlapping of broods. Heaviest feeding takes place in late summer and fall, when all life stages may be found. Because the trees may go through the winter without needles, poor vigor may render them susceptible to attack by bark beetles during the following spring.

The several species are alike in their manner of reproduction and feeding. The female cuts slits in the needles with a saw-like structure at the tip of the abdomen, and deposits an egg in each slit. The larvae feed in clusters and typically devour all of the needles on one branch before moving to another. When full grown each larva spins around itself an oval silken cocoon about 1/3-inch long. The cocoon, at first white and later shiny brown, is usually constructed within the duff or soil, less frequently in bark crevices or in the foliage. Larvae change to pupae within the cocoons, and thence to adults. Sawflies typically overwinter in cocoons. The loblolly pine sawfly is an exception in that it overwinters in the egg stage.

Signs of attack.—The larvae feeding in masses upon the foliage are usually quite conspicuous. Their greenish-brown excrement falling like raindrops and littering the ground, and the sparse foliage with short, yellowish needle stubs over most of the crown, also are obvious signs of attack.

Control.—Usually, sawfly infestations appear suddenly, continue for one or two seasons, and abruptly disappear. Armadillos, hogs, and particularly mice and shrews destroy the cocoons. Polyhedral virus diseases of the larval stage also provide natural control, as do a number of insects which parasitize or prey upon sawfly eggs, larvae, and pupae.

Where outbreaks are short-lived, growth loss of defoliated trees is not severe enough to warrant artificial control. Further, because outbreaks usually are sporadic and not noticed until the damage has been done, there is insufficient time to actuate a control program. The red-headed pine sawfly and the loblolly pine sawfly are the most likely to reach outbreak proportions. If defoliation by the former occurs repeatedly in the same plantation, chemical control may be advisable (see page 1).

Infestations of the loblolly pine sawfly may be affected by the time of year that logging is done. The insect passes the warmer months in a cocoon in the duff. Adults emerge in November and deposit eggs that hatch in the spring. Now, if partial cuts are made during summer and fall, insect numbers will be little affected but food will become limited. Eggs deposited in November, therefore, will be confined to fewer trees and subsequent larval feeding will be noticeably greater. Conversely, removal of trees in winter will help to suppress the insect, because eggs left in logging slash have little chance for survival.

PINE WEBWORM

Tetralopha robustella

Pine webworms feed on the needles of nursery, planted, and natural-grown seedlings, sometimes stripping trees less than 2 to 3 years old. The webworms are the larvae of a colorful moth that is seldom observed in the field.

Habits.—The moths appear from May to August and lay eggs on the foliage. They have a wingspread of about 1 inch. The front wings are transversely banded with dark purple scales at the base; the middle part of the forewing is gray, and the outer portion dark gray or black. The hind wings and body are smoky gray. The larvae or caterpillars feed from July until cold weather. Their heads are tan with darker markings; the body is yellowish with two dark-brown stripes along both sides. Each larva constructs a silken web about itself, and the webbing soon becomes packed with brown excrement particles which conceal the insect. Typically the web is 1 or 2 inches long, oval, and sac-like. Sometimes two or more larvae live in the same web, which may become 5 or 6 inches long and involve most of the seedling. When fully fed, the $\frac{3}{4}$ -inch long larvae move into the soil and pupate. One or two generations are produced each year in the South.

Signs of attack.—Defoliated and sometimes dead seedlings, and globular masses of webbing impregnated with brown excrement particles on stems and branches, are the most common signs of this insect. From July to November the caterpillars may be found in the webbing, but abandoned webs may persist on the foliage through the winter and spring.

Control.—Control is not usually necessary. Heavily infested nursery stock should be fumigated with methyl bromide before it is packed or shipped. In young plantations, hand picking and destroying the webs and larvae in September or October is the cheapest method of control.

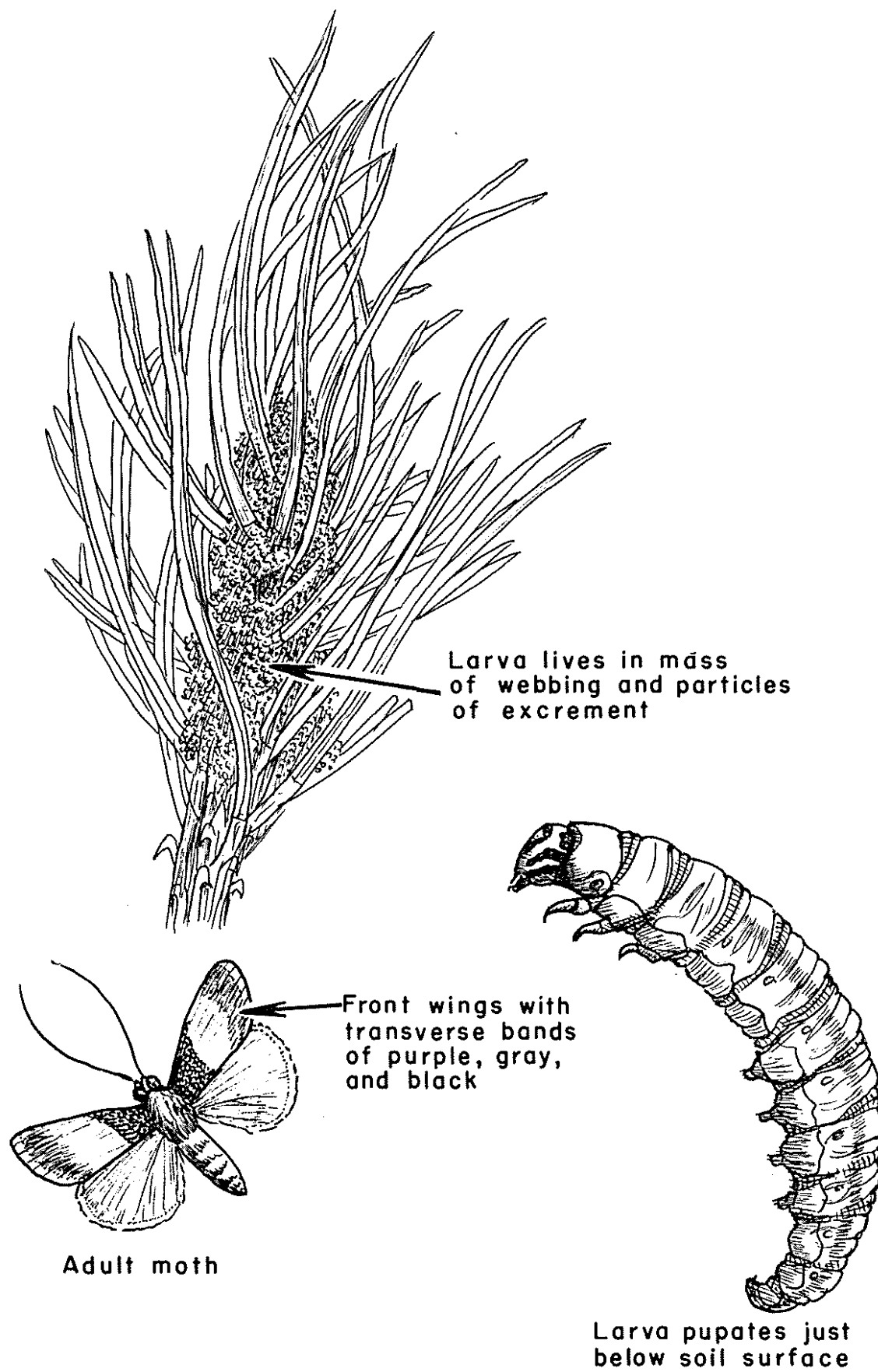


Figure 12.—*Pine webworm*.

PINE COLASPIS BEETLE

Colaspis pini

Feeding by the adult pine colaspis beetle produces a spectacular reddening of the foliage similar to that caused by fire. Young plantation pines growing in or near abandoned fields are most commonly fed upon. Slash pine seems to be attacked more often than other species. The beetle does not kill pines and apparently has slight effect on their growth. Infestations occur sporadically and at random throughout the South.

Habits.—The beetles are $\frac{1}{4}$ -inch long, oval in shape, tan with brown stripes and minute greenish jewel-like specks over the body. From May to early July they feed in groups on recently formed needles, leaving developing shoots and old foliage untouched. At times several hundred acres of natural and planted saplings may be attacked, but infestations usually are spotty, with the affected trees occurring singly or in small groups. Eggs are deposited in sod, upon the roots of which the larvae feed. One generation is produced each year.

Signs of attack.—The first evidence of attack is the presence of small drops of resin on the needles. At night the drops are highly reflective and appear to be luminescent when a light is flashed upon them. The foliage later becomes red, then brown, and an examination will reveal irregular saw-like edges along the needles, particularly those in the upper portion of the crown.

Control.—Infestations are rarely important enough to require chemical control. The insect may reach alarming proportions in an area one year and then appear elsewhere the next. It is impossible to predict where outbreaks will occur next, and they are usually discovered after the damage has been done. Trees recover in a few months, without noticeable aftereffects.

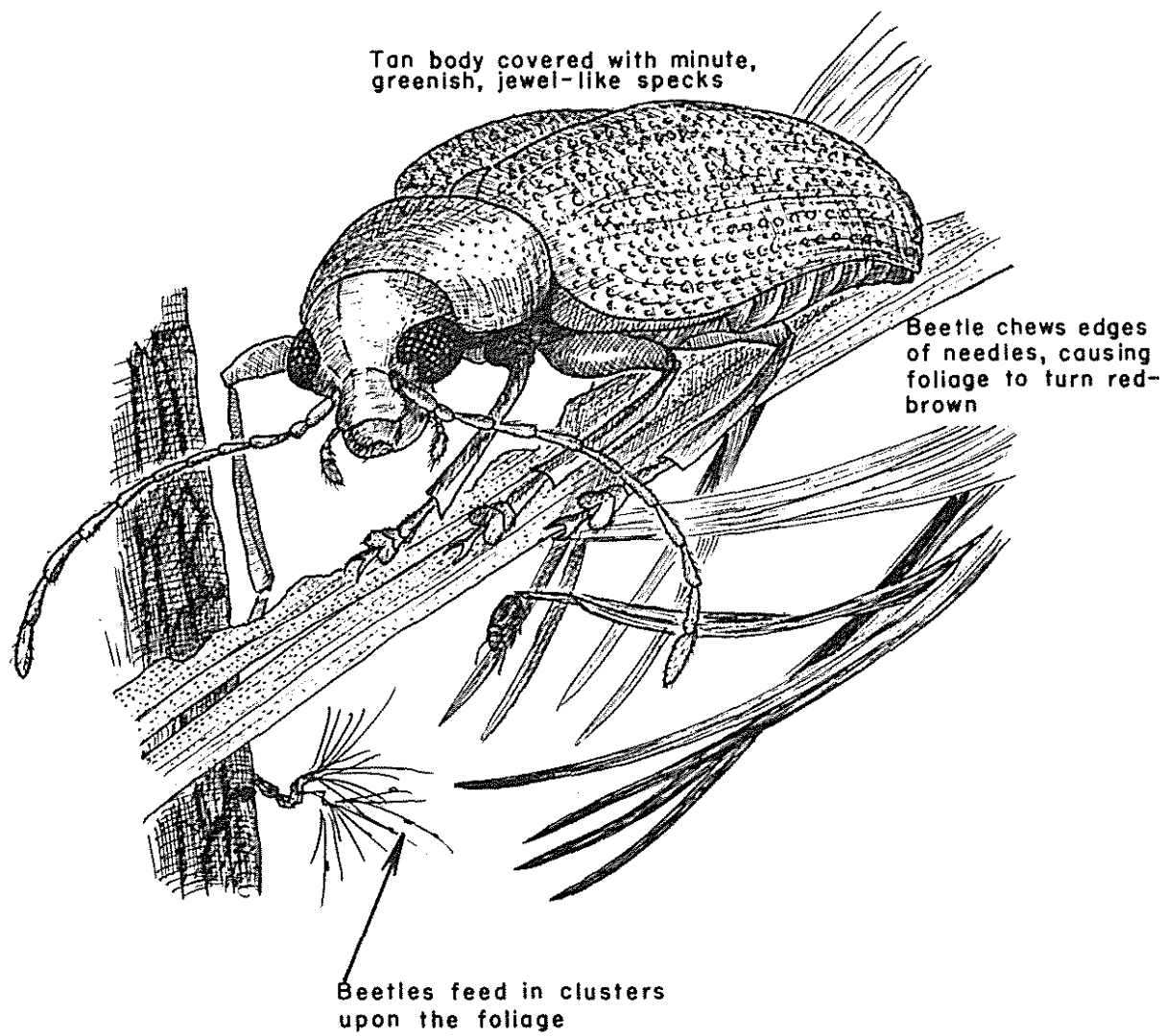


Figure 14.—*Pine colaspis* beetle.

TEXAS LEAF-CUTTING ANT

Atta texana

The Texas leaf-cutting ant, or town ant, is one of the worst enemies of pine seedlings in east Texas and west-central Louisiana. Where ant towns are numerous, they must be eradicated before pines can be established. The ants strip needles and leaves from a variety of plants, including pine and hardwood trees and many field crops. Large trees may be defoliated within several days, and small plants within a few hours. Pines are damaged most severely during the winter, when other green vegetation is scarce. Trees of sapling size or larger usually survive, but seedling stands are often wiped out.

Habits.—The ants do not eat the leaves or needles. Rather, they cut them into fragments and carry them below ground to make the “soil” for growing a fungus upon which they depend for food.

During their foraging, the ants clear trails that resemble miniature highways. They file along these trails, carrying leaf or needle fragments like tiny parasols. Defoliation by these ants resembles the work of several other leaf-chewing insects, particularly sawflies. Usually the injured trees are within sight of one of the colonies, or the ants themselves may be seen cutting the needles. Bits of the needles are left about the base of the trees and along the trails, which often extend several hundred feet.

The colony is made up of a large number of circular or semi-circular mounds, each with a funnel-like opening. A colony, or town, may cover from several square feet to a quarter of an acre or more, depending upon its age. During late fall and winter the fresh mounds of subsoil in the towns are very conspicuous.

In May and June, winged ants swarm and mate, and the females (queens) establish new colonies. Upon leaving her home colony each female carries in her mouth a small amount of fungus, which she cultures and subsequently uses to feed her young.

Activities of the ants are influenced by the temperature. The workers forage during mild days in winter, and mostly at night in

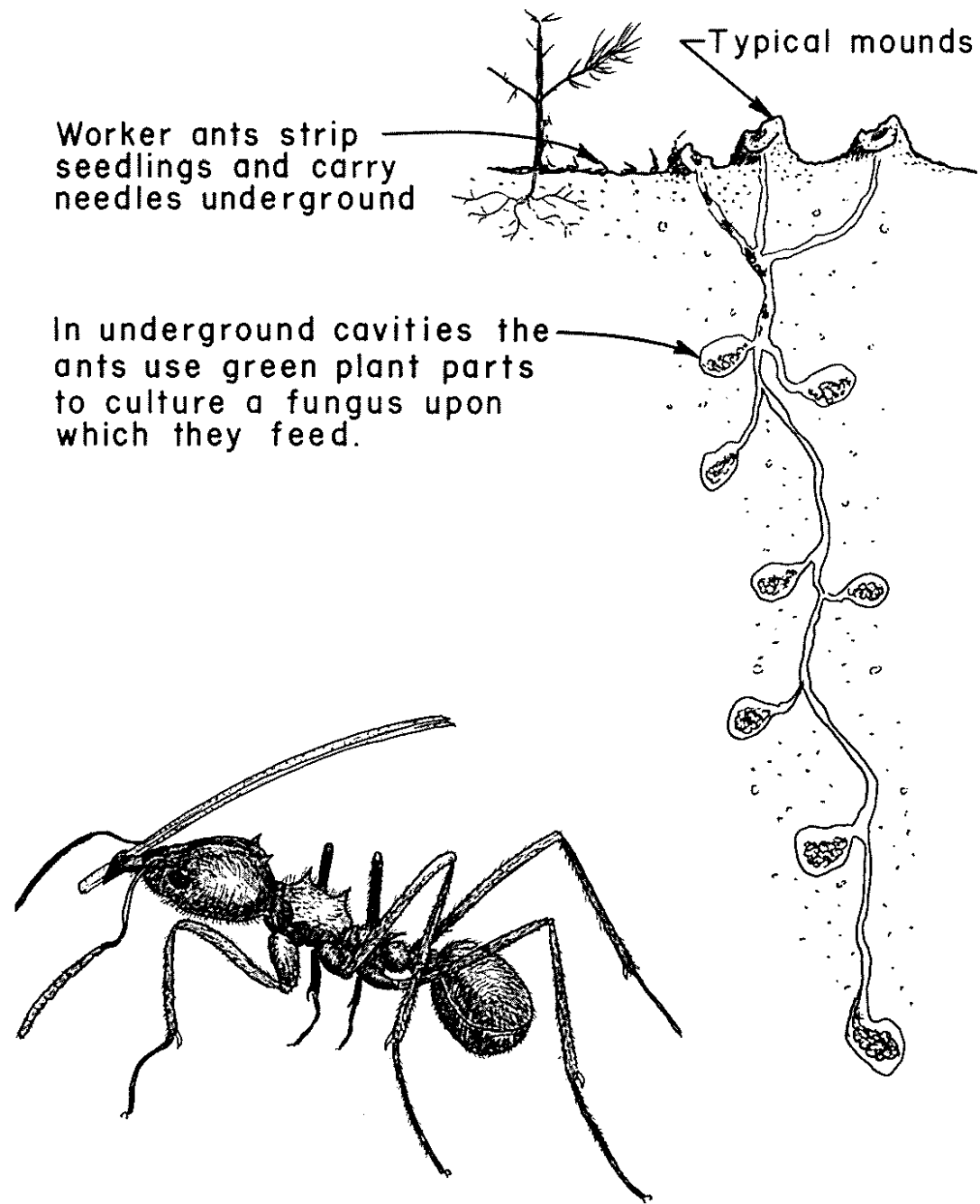


Figure 13.—Texas leaf-cutting ant.

summer. They are inactive on cold, wet, or cloudy days, particularly in the morning.

Within their natural range, the distribution of the ants is apparently limited by soil type. Most colonies are on sandy soil. A deep sandy surface soil underlain by a layer of clay seems to be preferred. On sloping ground, most colonies occur on southern and western exposures.

Control.—When signs of the ants are found on areas to be planted or seeded to pine, a systematic effort must be made to locate all nearby colonies. Scouting is easiest during the fall and early winter, when the mounds are not hidden by vegetation. As they are located, colonies should be marked with a stake or other device to guide the control crews to them.

Mirex pelleted bait is the most effective control devised so far. The pellets are applied evenly over the central nest area where most of the mounds are concentrated. For a medium-sized nest of about 150 mounds, about 1 pound of the bait is recommended. For smaller or larger nests, proportionate amounts from $\frac{1}{4}$ pound to 6 pounds should be adequate.

Mirex can be applied at all seasons, but applications should not be made during periods of rain or prolonged freezing weather. Pellets can be spread either by hand or with a machine—if by hand, the worker must wear rubber gloves.

The bait can be obtained in local seed stores under the name² Mirex Pelleted Bait “450”®. It should be stored so that it will not become contaminated by volatile materials such as oil, insecticides, or herbicides.

² Trade names are mentioned solely for information. They do not imply recommendation by the U.S. Department of Agriculture to the exclusion of other products that may be equally effective.

OTHER PINE INSECTS

The pests described below usually are not considered serious under forest conditions even though their presence sometimes may become alarming. Generalizations about the importance of an insect, however, may be short-lived. Occasionally, large populations of a so-called minor insect build up in limited areas or on individual trees. Too, there is always the possibility that a small but widespread population may rapidly develop into a serious menace to vast forest areas. And who knows how future changes in timber management may alter the behavior of any of the many innocuous insects? The black turpentine beetle, now an important enemy of southern pines, was once of little significance.

Pine needle miner (Exoteleia chillcotti).—The tiny, yellow-brown caterpillars hollow out the needles of pulpwood-size and larger longleaf pines, leaving the outer ends of the needles dead and semitransparent. Heaviest feeding takes place in spring and early summer when the larvae—sometimes the dark-brown pupae—may be observed by holding the foliage to the light. Vacated needles have a pin-sized exit hole and contain particles of excrement and strands of silk. When infested trees are observed from a distance, the foliage appears to be dying. Although some growth loss may be expected, damage is usually minor.

Pine pitch midge (Retinodiplosis sp.).—The orange, legless larva of this midge feeds singly or in groups in marble-size globs of resin exuding from pine twigs. When full grown, the larva is about 1/8-inch long. In some years this insect is very common. The twigs swell at the point of injury, and some are killed or break off several months after the insects leave. Damage, however, is minimal.

Scale insects (Coccidae).—Scales are soft, waxy insects that suck sap from plant tissues. The adult females hardly resemble insects, as they are legless and scale-like, and do not move. The newly hatched young, barely visible to the eye, have six legs, and are known as crawlers. They move about over the twigs and needles, and are carried to other trees on the bodies of wasps and other insects and on the feet of birds.

The pine needle scale (*Phenacaspis* sp.) is a white, elongate, oyster-shaped scale insect about 1/8-inch long. It attaches itself to the needles. When numerous the overlapping scales make the needles appear white. The pine bark scale (*Toumeyella* sp.) is a soft, brown, pea-size species that resembles a fully engorged tick. Crowded masses of the insects cover the twigs, branches, and sometimes the main stem of seedlings and small saplings.

The foliage of heavily infested pines becomes yellowish or brown and covered with a sticky "honeydew" excreted by the insects. A black, sooty mold eventually grows over the honeydew and increases the unsightliness. Small ornamental pines and occasionally plantation seedlings are killed. Control is not recommended under forest conditions.

Aphids (Aphidae).—Aphids or plant lice are light green or brown, soft-bodied, long-legged insects, varying from 1/16- to 3/8-inch in length. Both winged and wingless forms occur. Their heads are almost as wide as their bodies, and each individual has a pair of button-like or tube-like projections on the back near the tip of the abdomen. Aphids suck sap from the needles, branches, or roots. Infestations draw attention because of the yellowish foliage and sticky honeydew which attracts ants and bees. As with scale insects, a black sooty fungus may cover the honeydew on the needles and twigs. Chemical control is unnecessary or impractical under most forest conditions.

Spider mites (Tetranychidae).—Mites are not insects but organisms closely related to spiders and ticks. There are many species of these microscopic, eight-legged creatures.

Mites are among the most persistent of plant-feeding species; they cause foliage to fade and later turn brown. Damage is most severe during hot, dry weather. When infestations are heavy, mites can be found all over the foliage, running along the fine webbing that they spin. Though they are very small, their presence may be easily determined by jarring them off the needles and twigs onto a sheet of white paper. If living mites are absent, their pearly-white, transparent egg shells, cast skins, and webbing usually can be seen with a hand lens on the bark scales and needle bases of infested twigs.

During droughts, thousands of acres of pine forests may become infested. The rusty-brown trees may appear to be dead, but they recover after a soaking rain. On ornamental and shade tree pines, mites may be destroyed by thoroughly washing the foliage with a strong stream of water from a garden hose.